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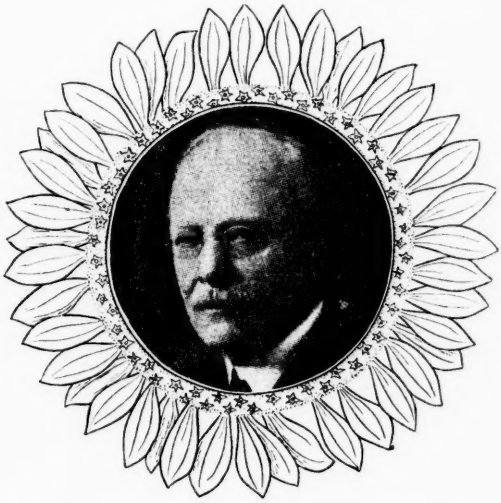

**SAMUEL WENDELL WILLISTON**
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# AUTOSPASY AND REGENERATION IN THE ROACH, BLATTELLA GERMANICA (LINNAEUS).

LAURENCE C. WOODRUFF, Lawrence, Kansas*

One of the more fortunate innate powers of living organisms is their ability to repair injured or lost tissues and parts. In an antagonistic and competitive world all living creatures are constantly beset, through injury and disease, with the problem of replacing the affected areas or succumbing to the results of the disaster. This restoration varies in extent from the healing of the slightest wound to some of the amazing examples of regeneration displayed by such animals as Planaria whose recuperative capacity virtually involves complete reproduction. In the last analysis all such repairs are merely phases of growth and differ physiologically only in extent.

With this viewpoint in mind, it is not surprising that cases of regeneration are encountered repeatedly in all living organisms, but it is only when these are of such extent that they involve the replacement of some integral part of the body that they attract particular attention. Nearly all plants have remarkable powers of regeneration as are indicated in their vegetative methods of reproduction. Thus, whole plants may develop from a detached leaf of Bryophyllum, from a portion of a potato tuber, or from a bit of the stem of a rose. Many a farmer has been astounded to find certain kinds of freshly set posts sprouting and growing into normal trees. While generally less developed among the animals, striking examples of this phenomenon are to be found in all of the principal phyla, being more highly developed where cell differentiation is slightest. Among the higher animals the process of regeneration is limited to such an extent that in man even minor wounds often leave scars.

In the Arthropoda powers of regeneration seem to be confined to the appendages, and wisely so, since these segmented structures, while serving the animals well in

*Contribution from the Department of Entomology, University of Kansas.

locomotion, feeding, sensation, and other activities, are for this very reason subject to injury and mutilation through contact with the environment. The literature dealing with the regrowth of appendages in the Crustacea alone is voluminous, but all of the major classes have been mentioned also and it is quite likely that regeneration occurs in most of the minor groups even though specific records are lacking. Few problems have produced as much theoretical speculation, especially in the publications of the marine biological stations where the chief animals of research have been decapod crustaceans.

Although regeneration is commonly acknowledged as being spread widely throughout the insect group, specific citations are surprisingly meager. Bourlet (1839), Lubbock (1873), and Morita (1926) have reported the regeneration of amputated appendages in the Thysanura and Collembola, chiefly in the antennae where growth initiates from the point of severance. Dragon-fly naiads have been found to reproduce legs by Watson (1891) for Agrion and by Bennazzi (1929) for Aescha. Lubbock (1864) observed that the terminal segments of the antennae in the young of Chloen (Ephemerida) were not reformed. In the Hemiptera, Gabler (1932) has noted the regeneration of antennal segments in five species. Numerous observations for the Orthoptera have been made, especially in the Phasmidae by Bordage (1897, 1898), Friedrich (1930), and Staudinger (1930) and in the Blattidae by Heineken (1829), Brindley (1897, 1898), and Illingworth (1916). The power of replacing lost legs among the Saltatorial Orthoptera is usually supposed to be absent, but Graber (1867) observed the reproduction of antennae in Gryllus and Locusta, so it is quite possible that the other appendages of these insects may have an equal ability. The ease with which the jumping legs of grasshoppers are lost may also be indicative of a subsequent renewal. For the Holometabola, the known records are for various lepidopterous larvae by Watson (1891), Newport (1844), and Kopec (1923).

Closely associated with regeneration in the Arthropoda will be found cases of autotomy or related phenomena. Whenever an animal possesses the ability to regenerate a lost or injured appendage, almost invariably such regrowth is merely a secondary manifestation of the previous activity of sloughing that member, either

reflexively or as a result of some extrinsic force. The term autotomy as proposed by Fredericq (1883) refers to the act of involuntary self-amputation, but its meaning has been loosely construed to include all losses of appendages from whatever cause, and even the subsequent regeneration. This is an unfortunate application but is due, at least in part, to the lack of a more general expression. Recognizing that some amputations, while occurring easily at predetermined loci of weakness, were not automatic, Pieron (1907) used the term autospasy to describe cases when an external pull must be applied to induce severance. Wood and Wood (1932) further clarified these terms by designating as autotilly the voluntary act of removing an injured appendage at points of weakness through the use of mouthparts or legs. These authors point out many bona fide instances of autotomy among the Crustacea, describing the mechanisms involved, and conclude that the range of these phenomena appears to have an evolutionary significance, since a graded series of forms showing autospasy, autotilly, and finally autotomy, conforms to the usual systematic arrangement.

In view of the specificity in the meaning of the term autotomy, as well as the confusion which has arisen from its broader use, and because of the lack of a general expression which would include all phenomena of a related character, a new derivative, appendotomy*, is hereby proposed to describe the loss of any appendage at prelocalized points of weakness through the activity of any force, irrespective of its origin. Autotomy, autotilly, and autospasy are then specific cases of appendotomy, differing from each other in the cause and nature of the disjointure.

While little research has been done with insects and no exhaustive canvass of the group has been attempted, even for those in which regeneration is known to occur, it would appear from the information at hand that true autotomy is not possessed by insects. But in spite of being deprived of special muscles to effect a reflex amputation, insects derive material advantage from the posses-

*This is admittedly a term of dual origins but by mixing the Latin and Greek sources the connotation was found to be more clearly apparent and the word more euphonious than any pure combination available. This should be as useful an expression as appendectomy, sociology, and other hybrid derivatives already established in the literature.

sion of predetermined loci of weakness known as breaking-points in as much as a leg or antenna may be easily severed at one of these points when subjected to an external pull (autospasy) as might be exerted in the grasp of an enemy.

## AUTOSPASY

The roach, **Blattella germanica** (L.), appears to have several well-defined breaking-points, one on each antenna and two on each leg. No such weakness has been noted for the mouthparts or cerci, although separations may be caused in these appendages if sufficient stress is applied.

The antenna of the roach is the generalized structure which might be expected, consisting of three segments, a stout scape articulating with the antennifer of the head, a second somewhat smaller segment, the pedicel, and a long tapering flagellum which is made up of many subsegments. If the flagellum be grasped with forceps near the tip, a break will occur at any of the subsegments near the point of seizure with no indication of a specific breaking-point. But if the pull be exerted at the middle of the flagellum, or more basad, the separation always appears between the scape and pedicel. This certainly points to the presence of a congenital fragility between these two segments. The breaks nearer the apex of the flagellum probably represent only a graduated structural weakness in the annulations correlated with the tapering size of the subsegments and are not to be considered in the same light as the true breaking-point at the union of scape and pedicel.

The structure of all legs in the roach is approximately the same. The coxa is a rather large and somewhat flattened segment which articulates basally with the pleural coxal process and the trochantin, and distally with the trochanter. The trochanter is more or less firmly fixed to the femur so that there is no movement at this point but the femoro-tibial and the tibio-tarsal joints are free and may be readily flexed. The tarsus consists of five subsegments which are freely movable upon each other although no sclerotic points of articulation are present.

Two constant planes of detachment are apparent in each of the legs, one at the tibio-tarsal joint and the second between the trochanter and femur. The entire tar-

sus readily disengages from the tibia under the influence of a strain from the distal end. but no tendency toward fracture is evident between the subsegments. When stress is applied to the tip of the tibia, disjointure always occurs at the immovable junction of the trochanter and femur. Extreme force may cause separation at other joints if the normal fracture-planes are protected from strain. but under natural conditions such breaks have never been observed. The ease with which the legs may be detached indicates a congenital weakness at these points, but there is no evidence that true reflex sloughing (autotomy) occurs. In a few cases, where a tibia or femur had been bisected artificially, that portion of the leg remaining beyond the trochanter was subsequently found missing, but in no instance was there the immediate sloughing so characteristic of autotomy. It seems probable, then, that the loss of appendages with the roach is of the type know as autospasy, but that occasionally injured members may be voluntarily removed from the body (autotilly).

## REGENERATION

Regeneration in the roach, as with all Arthropods, occurs only at the time of ecdysis, normally at the first moult following the amputation. If the injury is inflicted a comparatively short time preceding the moult, the reproduction of the lost part may be delayed until the end of the following instar. Naturally some time is required for the growth of the new tissues and complete formation cannot be effected in a few hours. Regenerated parts are usually reduced in size as compared with the normal structures, and frequently appear to be of little use to the insect since their movements are slow and clumsy as though the new muscles were not fully developed. With each subsequent moult, however, the reproduced structures grow larger and stronger and if given enough time may equal a normal appendage. Zeleny (1905) and Bennazzi (1929) have shown that the rate of regeneration is directly proportional to the size of the lost part or to the extent of the injury, and the mere fact that the reproduced parts may in time come to equal uninjured structures would point also to a more rapid growth in regeneration than is normal in the animal.

Antennal segments and subsegments of the flagellum are readily regenerated in the roach. If the break

has occurred between the subsegments near the tip of one of a pair of antennae, the two are usually almost if not entirely equal following the moult, certainly after a second moult. If the fracture is at the breaking-point between the scape and pedicel, complete regeneration is more slow. The renewed pedicel is approximately of normal size, but the flagellum will be reduced greatly in diameter as well as in length.

Cerci are regenerated in much the same way as the antennae, but no efforts were made to induce this phenomenon in the segmented appendages of the mouth-parts.

Quite naturally, the re-formation of the tarsus alone takes place with greater facility than when more of the leg segments are involved. This may be associated with the fact that the tibio-tarsal breaking point is somewhat less tenacious than the trochanto-femoral. At any rate, tarsi are regenerated almost invariably with the next moult and frequently may be of normal length. Without exception, however, the regenerated tarsus consists of but four subsegments. Brindley (1897, 1898) noted this unusual occurrence and discussed the confusion which resulted from the early descriptions of roaches wherein the tarsus was attributed as having only four subsegments. Illingworth (1916) records the same behavior for Hawaiian roaches, stating that "when tarsi are renewed, they lack the fourth segment in every case." It is not exactly clear just what is meant by the "fourth segment" but the present observations would indicate that either the second or third subsegment is the one involved. In the normal leg the second and third subsegments are more or less alike while the first, fourth, and fifth are fairly distinct and easily recognized even in the regenerated tarsus. The fourth subsegment is markedly smaller than the others and possesses a fleshy lobe on the ventral side. The penultimate subsegment in the renewed tarsus fits this description and is not at all like the third normal subsegment. Of course, the whole situation is obscured by the fact that the reformed subsegments are enlarged so that the total length of the four approximates that of the normal tarsus of five parts but the identity of the first and of the last two subsegments remains distinct throughout the procedure. This reduction in parts is characteristic of the tarsus even when additional segments are in-

volved in the regeneration and the normal number is not completed during any of the succeeding moults.

When the break arises at the union between trochanter and femur, or when the tibia or femur are bisected, the lost parts are regenerated at the next moult and, with the exception of the reduced number of subsegments in the tarsus and a diminution in size, the new structures are normal. It has been claimed (Brindley, 1897, 1898; Illingworth, 1916) that regeneration does not occur when the separation is closer to the body than the trochanto-femoral joint, but such has not proven to be entirely true. Bisection or forcible removal of the trochanter resulted in regeneration only perceptibly less rapid than when this segment was left intact. The effects of hemisecting the coxa are more severe. In fact, whether because of the more profuse bleeding or because of the greater extent of the injury, the incidence of moulting was considerably prolonged. In addition, a longer healing period is necessary between the amputation and the moult, for in several instances no indication of regeneration was displayed when this period was shorter than a week. The new leg after this manner of dismemberment was always of materially diminished size and frequently incomplete, consisting only of trochanter and femur in addition to the coxa, or perhaps also a rudimentary tibia. The missing segments are sometimes completed during later moults, but the new leg is seldom normal in size or strength.

Mutilation of one leg apparently has little effect upon the regeneration of another except in so far as the locomotion of the insect is impaired and its ability to feed thus hampered. Multiple injuries to legs or to legs and antennae seem to be repaired at the same time with no decrease in rate.

Staudinger (1930) has reported instances of homoeosis with **Carausius (Dixippus) morosus** wherein abnormal structures are interpolated between the segments of the regenerated appendages, or where normal segments are out of place or in reversed order. Similar phenomena have not been encountered in this species of roach, unless one considers the loss of a subsegment in the tarsus as a manifestation of this principle.

## SUMMARY

The general term appendotomy is proposed to in-

clude all losses of appendages by Arthropods, whether this severance be effected by reflex sloughing (autotomy), by an extrinsic force (autospasy), or by self-amputation (autotilly).

In **Blattella germanica** (L.), appendotomy is effected only by autospasy in the majority of cases, but autotilly may occur. A similar condition undoubtedly prevails with most insects which exhibit any ability of regeneration.

Fractures normally occur at prelocalized points of weakness. The roach has at least fourteen of these breaking-points, one on each antenna between the scape and the pedicel, two on each leg at the trochanto-femoral and tibio-tarsal joints.

Appendotomy is usually followed by regeneration of the lost parts at the next ecdysis and in this species of roach missing segments of the antennae, cerci, and legs are readily restored. In the legs, the renewal may arise at the joint between any two segments, or even where a segment has been hemisected, but is more apt to originate at the breaking points. The facility with which regeneration takes place on the leg apparently decreases as the location of the injury approaches the body. In all cases observed when a tarsus had been replaced, whether alone or with other segments of the leg, it consisted of but four subsegments rather than the normal number of five.

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# FIVE NEW SPECIES OF LEAFHOPPERS (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kans.*

**E. juncea** n. sp.

Resembling **E. rufostigmosa** Beamer but noticeably smaller and more slender, median stripe narrower, venter light, vertex acute, anterior point of foot not just a right angle.

General ground color semihyaline to muddy white, with distinct median red stripe. Vertex with mesal orange to red stripe, not touching eyes, continued as broader band across pronotum, occupying all of scutellum and most of clavus, outer margins of this band much brighter. Second pair of oblique vittae of elytra present, arising on Cu, anterior third lemon yellow, remainder red. Apex more or less infuscated. Venter stramineous.

Genitalia: Style with foot of medium size, heel prominent; base straight, anterior point short and sharp, posterior point long, almost half as long as foot, narrow. Aedeagus long, in lateral view, sides almost parellel, opening about one-third distance from tip.

Holotype male, allotype female, 2 males and 16 female paratypes, Likely, Florida, July 24, 1934, R. H. Beamer. Swept from scrub oak on sand dunes.

**Erythroneura caerula** n. sp.

Resembling **E. mixta** Beamer but black in color, shaft of aedeagus shorter, sides not parellel, apex enlarged, hooks recurved.

Color: Black throughout except lateral margins of vertex between eyes and apex and costal palque yellowish white. Costa beyond costal plaque usually wine red. Abdomen more or less black, remainder of venter light except mesosternum which is black.

Genitalia: Style with short foot; anterior point short, about a right angle; posterior point longer than foot, narrow, sides converging to sharp point. Aedeagus larger than in either **E. rubricata** Van D. or **E. mixta** Beamer, in dorsal view, wide at base, narrowing toward

*Contribution from Department of Entomology, University of Kansas

tip where it again widens to end in three recurved processes.

Holotype, male, allotype female, 5 males and 23 female paratypes, Barnes, Arkansas, June 8, 1931, R. H. Beamer.

This species was taken with brown specimens of **E. rubricata** Van D. from **Hypericium** sp. growing in low bottom lands.

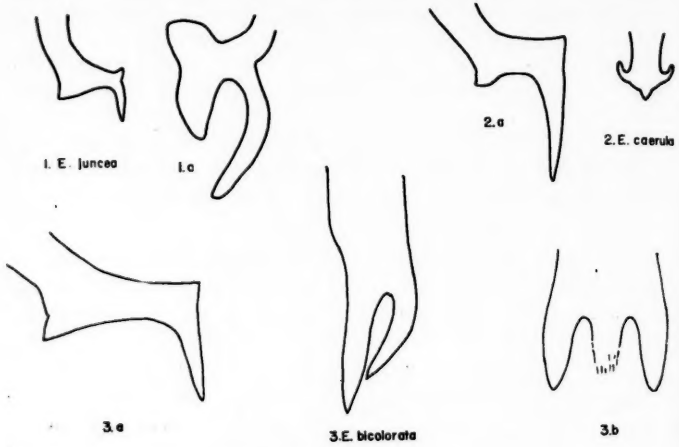
**Erythroneura bicolorata** n. sp.

Resembling **Erythroneura vulnerata** Fitch but easily distinguished from that species by having anterior half of body dark colored and posterior light, and by having a much larger chelicerate pygofer hook.

General ground color of anterior half dark brown of posterior semihyaline to white tinged with pink. Vertex with narrow median longitudinal white line enlarged at either end, a semblance of two spots on either side and vertex margin white. Pronotum with two rather definite triangle on posterior margin either side of middle, and anterior margin, especially the corners spotted with white. Scutellum more or less longitudinally striped with light. Elytra back to a posteriorly curving line from anterior margins of costal plaque through posterior third of clavus dark with some lighter areas, beyond this light more or less suffused with pink, apical cells somewhat infuscated. Venter dark, more or less marked with white.

Genitalia: Pygofer hook much larger than in **E. vulnerata,** bifid at apex, finger-like processes about as long as remainder of hook, almost touching at apex. Style with medium foot; heel large; base almost straight; anterior point slightly more than a right angle, posterior point narrow, and sharp, about half as long as foot. Aedeagus typical of this group with rather narrow, slightly diverging processes.

Holotype male, allotype female, 2 male and 1 female, paratypes, Douglas Co., Kansas, R. H. Beamer; 1 male paratype Colfax, Pa., December 23, 1931, R. H. Beamer; 1 female paratype, White Co., Ill., March 31, 1929, P. W. Oman.




**Hecalus balli** n. sp.

Resembling **Hecalus bracteatus** Ball but more slender and female with vertex more than twice as long as width between eyes instead of barely longer than wide. Length female, 9.5 mm, male, 5.5. mm.

Female: Vertex slightly more than twice as long as width between eyes, foliaceous, lateral margins almost parellel on basal four fifths, apex rounded, median longitudinal ridge, small but distinct, continuing across pronotum, vertex slightly concave either side median ridge. Ocelli on margin about one third distance to apex. Elytra short, covering about the first two abdominal segments, one fourth shorter than vertex, apices rounding, venation distinct but reduced.

Male: Vertex rounding, almost semicircular, slightly wider between eyes than mesal length, no mesal ridge, margins not foliaceous, ocelli about one half distance to apex. Elytra longer than abdomen, venation distinct.

Color: Female stramineous with an indication of darker longitudinal lines on abdomen. Male milky white.

Genitalia: Last ventral segment of female with more pronounced excavation than in **H. bracteatus.** Male plates more slender than in that species and aedeagus with a pair of heavy processes arising basally on ventral

side of shaft and extending more than half its length.

Holotype female, Cochise, Ar., E. D. Ball, allotype male and numerous male and female paratypes Cochise, Ar., August 24, 1935, R. H. Beamer. Holotype and paratypes in collection of E. D. Ball, allotype and paratypes in Snow Entomological collection.

This species was swept from a native grass near the railroad a mile or so east of Cochise, Ar.

**Cicadella curta** n. sp.

Resembling **Cicadella cucurbita** Ball but smaller, vertex sharper and median longitudinal white stripe extending from anteclypeus to the apex of clavus. Length female 4.75 mm, male 4.50 mm.

Vertex distinctly wider than median length; apex conical distinctly less than a right angle. Pronotum with lateral margins narrow, a deep median indentation of the posterior margin gives it a bilobed appearance. Venation not too distinct; clavus with two veins; corium with two crossnervures. Elytra covering abdomen.

Color:: General ground color stramineous. Median ivory stripe definite across scutellum, pronotum, vertex and post clypeus, bordered with fuscous. Black frontal arcs continuous where visible from above. Vertex with three pairs of black longitudinal stripes, first pair anterior to eyes, second touching ocelli and third, quite broad, bordering median stripe, continuing across pronotum and scutellum. Pronotum with an indication of the other two pairs. Elytra with veins whitish more of less bordered by fuscous, this dark coloring not approaching mesal margin closer than width of pronotal light stripe thus for length of clavus there is apparently a light band about twice as wide as the pronotal band.

Genitalia: Last ventral segment of female very broad, posterior margin sharply, triangularly produced with small mesal notch. Male plates smaller but about as in **C. cucurbita.** Aedeagus with long processes, thick on basal half, then sharply narrowed to lash like apices, right one much heavier and longer than left.

Holotype male, allotype female, and numerous paratypes, Roswell, New Mexico, July 16, 1936, R. H. Beamer. This species was swept from small patches (ten feet long) of a very short, thickly growing grass, often a half dozen sweeps of the net would yield 75 specimens. Adults and nymphs were present. Types in Snow Collection.

# THREE NEW SPECIES OF PHYLLOPHAGA (COLEOPTERA, SCARABAEIDAE) WITH NOTES ON TWO SPECIES NEW TO KANSAS.

MILTON W. SANDERSON, Lawrence, Kans. *

Recently, while working over the Phyllophaga material of the University of Kansas, and incorporating my own into that of the Francis Huntington Snow Collection, the writer encountered three new species which seem worthy of record. Unless otherwise indicated all types are deposited in this collection.

**Phyllophaga perita** n. sp.

Length, 16 mm.; width, 8.5 mm.

This species should be placed in or near Group XVII of Horn (Revision of the Species of Lachnosterna of America North of Mexico, Trans. Amer. Ent. Soc., XIV, 1887).

Form oblong, distinctly wider behind. Color reddish-brown with head and pronotum of the same general color. Surface shining.

Antennae 10-segmented with the club equal in length to segments 3-7 combined; color reddish-brown with the club perceptibly lighter. Clypeus slightly but distinctly emarginate with the margins on either side moderately reflexed; surface of clypeus and front with very large coarse punctures, these not regularly placed, and some of which open posteriorly.

Pronotum equally coarsely punctured but not quite as closely as on the head, and the punctures irregular, variable in size; an invading smooth area at the base on either side of center of pronotum; pronotum nearly twice as wide as long with basal angles rounded and nearly obsolete; marginal line almost obliterated; widest at middle and rather suddenly convergent and straight to apex which is narrower than at base. About a dozen large yellowish hairs arising along the crenate sides. An erect hair arising from each discal puncture on the central and posterior portions.

Elytra very distinctly dilated posteriorly with the surface nearly regularly and finely punctured, and with

* Contribution from Department of Entomology, University of Kansas.

the sutural costa distinct though not prominent; discal costae feeble; a few hairs arising near the base of the elytra and on either side of scutellum. In some regions of the elytra, the surface is slightly pruinose.

Pygidium moderately convex, not quite twice as wide as long finely punctured except near apex which is nearly smooth and bearing a very fine longitudinal carina. Surface rather closely placed with short stiff hairs.

Abdomen more densely punctured at sides than at middle and with the punctures very fine; disc very slightly flattened at middle but without trace of longitudinal impression; abdomen very convex just before the last segment which is very finely and irregularly rugulose.

Both spurs of hind tibia free, narrowed, slightly curved; the inner spur extending to nearly two-thirds the length of the second tarsal segment, the outer spur as long as the first segment. Claws very similar on all tarsi, strongly curved, and with a very broad median tooth.

Metasternum with long, yellowish, but very fine hairs.

Holotype male, Baboquivaria Mts., Ariz., F. H. Snow.

The present species is unmistakibly associated with **heterodoxa** (Horn) and **latidens** (Schffr.) by the general form of its anterior and posterior claws.

The three species may be conveniently separated:

1. Claws of middle tarsi of males dissimilar....**heterodoxa**
   Claws of middle tarsi of males similar ..... (2)
2. Disc of pronotum with very coarse punctures, and with a hair arising from each; abdomen without longitudinal impression ..... **perita**
   Disc of pronotum more finely punctured, and without vestiture; abdomen with a distinct longitudinal impression in the male ..... **latidens**

Perhaps the most conspicuous difference by which this species is distinguished from all known species is in the peculiar type of genitalia. The claspers are united beneath, and from each side near the apex there arises a spatulate process which projects at about a 45 degree angle from the plane of the upper aspect. It is probable that in life the distal ends of the processes are horizontal, but drying of the specimen after death, and preparation of the genitalia for study have produced the twisted effect as figured.

**Phyllophaga texana** n. sp.

Length, 19 mm.; width, 9.5 mm.

This species is to be placed in Horn's Group IX.

Form elongate-oval, subdepressed, slightly wider behind. Uniformly dark brown as in **rugosa** (Melsh.) with which this species is associated. Surface shining.

Antennae 10-segmented, the club equal to segments 2-7 combined. Clypeus rather deeply emarginate with margin moderately reflexed; surface moderately, closely and evenly punctate. Sides of front nearly as closely punctate as clypeus, but with the interspaces becoming larger toward the center; clypeal suture slightly impressed.

Sides of pronotum indistinctly crenate, subangulate at middle thence convergent both anteriorly and posteriorly; wider at base than apex before which there is a vague sinuation; disc shining, moderately, irregularly, and rather sparsely punctate, a nearly smooth median area, the punctures becoming closer toward sides of pronotum; disc somewhat depressed on either side of the middle.

Elytra strongly rugose, the punctures everywhere obliterated, except near base and sides; discal costae nearly obsolete, the sutural one more distinct and strongly rugose on the median two-thirds.

Pygidium convex, perceptibly wider than long, very finely and sparsely punctured, shining.

Abdomen finely and sparsely punctate below with a very few fine scattered hairs at sides; broadly flattened in the middle; penultimate segment with an oblique elevation extending posteriorly from near its anterior border, this segment deeply and suddenly depressed before the middle, coarsely punctate at sides, and becoming granulate toward the middle; last segment broadly concave and nearly smooth.

Fixed spur of hind tibia about one-half the length of the inner spur which is a little wider medially and slightly curved. Tooth of claw strong and median.

Metasternum finely and evenly punctate, and with the vestiture not dense.

Holotype male, Orange Co., Texas, Aug. 14, 1928. L. D. Beamer.

This species may be separated from its closest ally,

**rugosa** (Melsh.), by its more sparsely punctate head and pronotum, and by the shape of its genitalia. This structure is almost symmetrical, but nearly after the type of **knochii** (Schon.), and **rugosa.** It differs readily from either by having the posterior angles of both side pieces sharply acute and curved inward. The inside of the right clasper does not have the acute perpendicular ridge as in **rugosa,** but is smooth as in **knochii.** It is to be noted that the genitalia of this species nearly presents a borderline type between the truly symmetrical claspers, and those which are dissimilar. It is hoped that the accompanying figures will better show the peculiar characteristics of this organ.

**Phyllophaga howei** n. sp.

Length, 9-10 mm.; width, 5-5.5 mm.

About the size and form of **taxodii** Langston, but in Horn's table, keys to Group X based on antennal and tibial characters.

Form oblong-elongate, slightly wider behind. Color a pale, yellowish testaceous; head and pronotum darker and shining, elytra very slightly shining.

Antennae 9-segmented, testacious, the club nearly as long as the stem. Clypeus entire, rather strongly reflexed and excavated. Punctures moderate and separated by about their own diameters.

Sides of pronotum nearly parallel in basal half, though slightly sinuate before the hind angles, then evenly curved to the apex; the side margins distinctly crenulate and with a few hairs; disc with punctures rather closely placed and almost uniform in distribution, the interspaces being from about one-half to the width of the punctures.

Sutural costa of elytra distinct, the discal ones almost obliterated. Punctures on the elytra almost as closely placed as those on the pronotum, but scarcely as large or as deep.

Pygidium three-fifths wider than long, very convex, irregularly and moderately punctured on the disc before the apex which is very nearly smooth.

Abdomen broadly flattened medially, impunctate at middle but with very fine punctures laterally which become more numerous toward the sides; penultimate segment with a few long, erect hairs on either side of middle; last segment unmodified.

Holotype male, Fairfax, S. C., June 14, 1932, Edwin W. Howe, after whom the species is gratefully named. Paratypes, five males collected 15 miles northeast of Tallahassee, Fla., June 23, 1935, H. S. Peters. One male paratype labeled Leon Co., Fla., June 6, 1935, H. S. Peters. Paratypes in the collection of Mr. O. L. Cartwright, Clemson College, S. C.

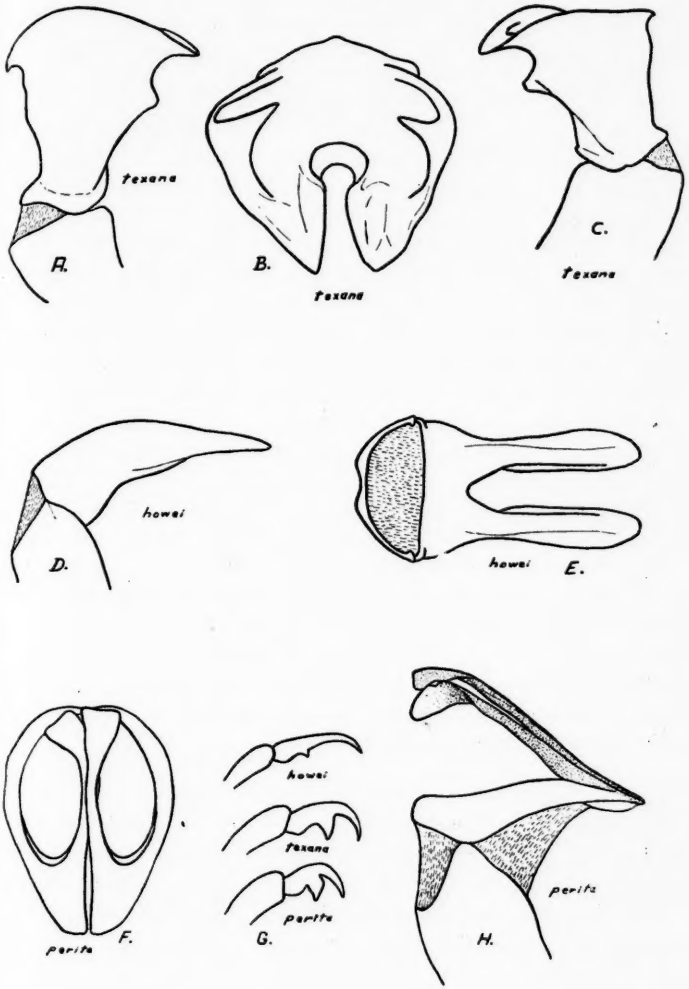
The paratypes are much darker and more shining than the type, and with punctures on the disc of pronotum slightly more irregular. In the small series, the fixed spur of the hind tibia varies from one-third to one-half the length of the inner spur.

This species is to be distinguished from the known members of Group X by its entirely glabrous upper surface, there being no evidence of hairs even on the front, which is characteristic of certain species within the group. In the type specimen a part of the abdomen was destroyed, and a description of its features was taken from the paratypes. The flattened surface approaches the unmodified type of **affabilis** (Horn). The genitalia are somewhat similar to that of **affabilis** but have the claspers united at their bases. Those of the latter species are free.

**Explanation of Plate**

A. Right lateral view.
B. Dorsal view.
C. Left lateral view.
D. Right lateral view.
E. Dorsal view.
F. Dorsal view.
G. Tarsal claws of new species described.
H. Right lateral view.

On May 30, 1935, near Galena, Kansas, Doctor R. H. Beamer and the writer took several specimens of **Phyllophaga arkansana** (Schffr.) feeding on oak, sassafras, and persimmon. May 23, 1936 near Elk City, Kansas, we took a single female of **P. karlsioei** (Linell) under a stone on a hillside. Both species were described from Arkansas, and are recorded here for Kansas for the first time.


texana
A.
B.
texana
C.
texana
howei
D.
howei
E.
F.
perita
howei
texana
perita
G.
perita
H.

# LIFE-HISTORY NOTES ON THE SPOTTED-SIDED CUTWORM (AGROTIS BADINODIS GROTE)[1]

H. H. WALKDEN, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

## Introduction

In the course of a general study of the cutworms of the family Noctuidae occurring in the Middle West, considerable data have accumulated relative to some of the more obscure or less well known species of this group of moths. The Spotted-sided cutworm (**Agrotis badinodis** Grote) belongs to this category, and although no outbreak of this species has even been recorded, it seems worth while to place on record the observations regarding it made during the past few years. In the vicinities of Wichita and Manhattan, Kans., where the observations were made, the species is of uncommon occurrence. Crumb (1), in his consideration of the tobacco cutworms, states that the larvae have very rarely been found in tobacco fields, and on but one occasion have they been taken injuring plants in a plant bed. However, the writer's observations on the food habits of the species lead to the conclusion that it is of potential economic importance on cereal and forage crops. A change in the ecological factors restricting its abundance might easily bring this species into prominence, inasmuch as certain other members of the genus are of considerable economic importance in the United States.

## Distribution

The present known distribution of this species comprises the northern Atlantic States and Canada, along the Atlantic Coast from New York to North Carolina, and westward to Iowa, Kansas, and Texas. (1), (3). Further investigations would probably enlarge this range.

## Host Plants

The larvae evidently have a rather wide range of

1 Order Lepidoptera, Family Noctuidae.

food plants. Crumb (1) records clover, **Rumex crispus, Sisymbrium officinale, chickweed, Aster ericoides,** and **tobacco,** and states that they have a decided preference for **Rumex** and chickweed. The writer has taken the larvae in clumps of volunteer wheat, in surface trash along roadside hedges, and in grassy areas adjoining wheat and alfalfa fields. They were also taken at night, feeding on the tender leaves of alfalfa.

### Seasonal history

There is but one generation annually of this species. During the years 1921-1930, inclusive, a record was kept of the Noctuidae taken at a baited trap at Wichita, Kans. In most years, the adults of **Agrotis badinodis** first appeared in the trap early in October. The greatest flight usually occurred during the first ten days of the month, although adults have been taken as late as November 2. Records of adults taken at trap lights, in 1934-1935, corroborate the results obtained with the baited trap.

The eggs are deposited soon after the females emerge, and hatch in about two weeks, normally in this region during the last ten days of October. In the laboratory, eggs deposited October 16 hatched October 30, at room temperature. The larvae feed to some extent in the fall and pass the winter in the larval stage, mostly in the third or fourth instar. In the latitude of Wichita, Kans., they no doubt feed to some extent when warm periods occur during the winter months. Field collections of larvae show that, by the last of March, a majority have passed the last molt. By April 20, feeding has practically ceased and they have entered the soil for pupation. Of the larvae collected in the field in March and early in April, the first pupation occurred on April 15 and nearly all had pupated by April 30. One larva did not pupate until May 16, and it is interesting to note that the adult emerged on September 26, the earliest date recorded in these observations. The summer is passed in the pupal stage within an earthen cell, the adults emerging early in October, thus completing the seasonal cycle. The seasonal history is shown graphically in Fig. 1.

### Life cycle

#### The adult

The adults are short-lived, only about two weeks of

the life cycle being occupied by this stage. Adults taken at the bait trap, of unknown age, lived a maximum of ten days after capture, and averaged eight days. In confinement, the females deposited eggs on the cloth covering of the cage and on alfalfa leaves, and scattered eggs promiscuously over the surface of the soil. Eggs were not observed under natural conditions, but in the cages the moths showed no disposition to place their eggs in masses. Seventeen females, reared from egg to adult in captivity, were dissected within twenty-four hours after emergence, and the eggs counted. The maximum number of eggs observed was 1,300, the minimum 536, with an average of 880 eggs per female. Oviposition occurs during the night and was not observed.

The sexes are apparently about evenly proportioned. Of 49 adults secured in various rearings, 25 were females, this figure being slightly more than 50 percent. However, in adults taken at the bait and light traps the males greatly outnumbered the females. At bait, the proportion was four males to one female, while at light the ratio was seven to one.

### The egg

In the laboratory, the incubation period of the eggs averaged about two weeks. No doubt it is somewhat longer under field conditions, owing to the lower outdoor temperature late in October. Eggs deposited October 16 hatched on October 30, and another group deposited October 18 hatched November 2.

### The larva

In making observations on the larval instars, the following method was followed:

The newly hatched larvae were placed in homeopathic vials, one larva per vial, and a single alfalfa leaf supplied to each for food. The vials were then plugged with cotton and put in holes bored in plaster of Paris blocks, the plugged end in contact with the plaster. Moisture was supplied by absorption from the plaster, which was kept saturated with water. In this way the food supply was kept fresh for at least 24 hours, and was changed if necessary at the time of the daily observation. The larvae were observed daily and the molts recorded,

as were the measurements of the cast head capsules. After the third molt, the larvae were placed in 3-ounce salve tins partially filled with sterilized soil. The food supply was put on top of the soil.

Two generations were reared in this manner. However, the first generation was carried through the winter in the laboratory basement where the temperatures were too high to induce hibernation. As a result the larvae fed actively throughout the winter and became full grown the last of January. They lingered for about a month and then began to die in large numbers, so that by the end of March very few remained. Altogether 13 larvae pupated late in March and early in April. From these 4 adults were secured, emerging late in June and early in July, more than three months ahead of the normal emergence period. This record is presented here merely to show how the species can be thrown out of balance by abnormal conditions.

The second generation was begun with eggs deposited October 18, 1926. These hatched November 2. The larvae were kept at room temerature until November 9, when they were placed in an outdoor cave. The winter temperatures in the cave occasionally fell to near the freezing point, and were sufficiently low to render the larvae inactive from early in December to mid-February. During the latter part of February the larvae had all resumed feeding and by the last of April had entered the soil preparatory to pupation. The first pupa was noted on April 20 and by May 9 all the remaining larvae had pupated. The first adult emerged September 11, and the greatest number of moths appeared during the period October 3-11. The summary of the life cycle is presented in table 1.

As the larvae molted, the cast head capsules were measured, the greatest width as seen from the front being taken. These measurements were remarkably constant within the instar, the variability being least in the first three instars. In table 2 is given a summary of the head measurements, representing observations on more than 100 larvae for each instar.

**Table 1.**—Summary of life cycle of **Agrotis badinodis** Grote

| | Number of days | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Egg | 1st Instar | 2nd Instar | 3rd Instar | 4th Instar | 5th Instar | 6th Instar | 7th Instar | Prepupal | Pupa | Larva | Egg to Adult |
| Maximum | 15 | 20 | 21 | 74 | 60 | 38 | 22 | 38 | 14 | 170 | 188 | 364 |
| Minimum | 14 | 6 | 8 | 21 | 28 | 17 | 9 | 25 | 3 | 119 | 169 | 315 |
| Average | 14.5 | 7.7 | 12.5 | 43.0 | 47.8 | 26.9 | 16.7. | 29.9 | 8.2 | 154.2 | 180.4 | 349.4 |
| Number observed | 200 | 96 | 95 | 91 | 83 | 53 | 47 | 31 | 31 | 28 | 31 | 28 |

**Table 2.**—Summary of head measurements of larvae*

| | Width of head capsule—mm. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1st Instar | 2nd Instar | 3rd Instar | 4th Instar | 5th Instar | 6th Instar | 7th Instar |
| Number of individuals measured | 154 | 167 | 168 | 158 | 127 | 111 | 0 |
| Maximum width - - - | 0.40 | 0.60 | 1.00 | 1.50 | 2.10 | 2.60 | - - |
| Minimum width - - - | 0.35 | 0.55 | 0.70 | 1.15 | 1.55 | 2.10 | - - |
| Average - - - - | 0.40 | 0.60 | 0.88 | 1.35 | 1.83 | 2.29 | - - |

Footnote to table—

*Owing to the fact that in the final larval molt, the head capsule splits, no accurate measurement could be taken.

### The pupa

Pupation takes place in the soil in an earthen cell constructed by the larva shortly after feeding ceases. A few weeks after pupation the pupal case becomes quite hard and it is difficult to determine whether or not the pupa is still alive since the pupa does not squirm but remains motionless within the cell. Of 28 individuals reared from egg to adult the longest pupal period was 170 days and the shortest 119 days, the average for the group being 154.2 days. Another group of 19 pupae from larvae collected in the field showed a maximum pupal period of 178 days and a minimum period of 133 days with an average of 165 days. This difference is probably due to the fact that the larvae in the life-cycle series were never subjected to freezing temperatures and consequently were slightly more advanced than larvae which had experienced winter conditions.

### Description of the stages

Grote's original description of the adult appeared in the Canadian Entomologist (2). Smith (4) also gives a description of the adult. Descriptions of the various stages are presented by Crumb (1). The interested reader is referred to the above named publications.

### Parasites and disease

Owing to the scarcity of the larvae, only meager notes on parasites and disease could be secured. Over a period of several years, a total of 38 larvae were collected. Of this number, 4 were parasitized by undetermined internal parasites, no adults of which were obtained. Two other larvae were killed by fungus, probably **Beauveria** sp. Crumb (1) records **Paniscus geminatus** Say and an undetermined dipteron as parasitic on this species, as well as several diseases.

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3.—Holland, W. J.
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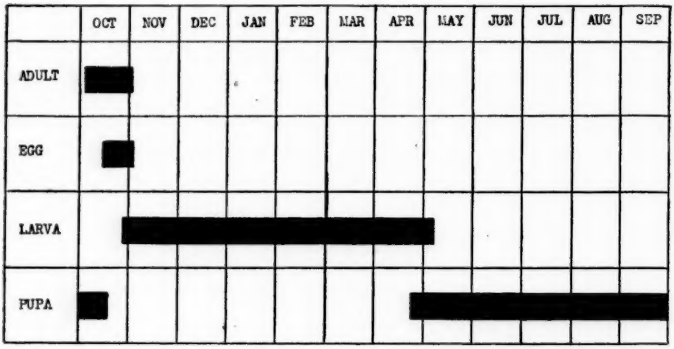
4.—Smith, J. B.
1890 Revision of the Genus Agrotis. U. S. Nat. Mus. Bul. 38, pp. 61-62.

Fig. 1. Seasonal History Chart, Agrotis badinodis Grote




## NOTE

### FOOD OF **BIBIO PAINTERI**

In the Journal of the Kansas Entomological Society for October, 1935 (vol. 8, pp. 145-146), the writer noted the feeding habits of some adult Bibionidae, tentatively identified at the time as **Bibio xanthopus** Wied. Attention is hereby called to the fact that these notes henceforth be referred to **Bibio painteri** James, since Mr. M. T. James has described the specimens under that name in a recent paper on "Some new western Bibionidae" (Amer. Mus. Novitates, 832, p. 2. March 26, 1936).

CURTIS W. SABROSKY.

# A MOLE-CRICKET AT BAY

MELVIN E. GRIFFITH, Lawrence, Kansas*

Many observers—some of them unintentional naturalists—might prepare out of personal experience a scathing indictment of the skunk for demonstrated antisocial conduct. Those who have fully received evidence of the ill-favored vertebrate's displeasure will appreciate the extremity of the measure serving also in the defense of that unique insect, the mole-cricket. Several writers** have discussed the very sticky, fetid discharge of **Gryllotalpa** and **Scapteriscus,** and the glands responsible for its production. To these admirable reports from the laboratory may be appended the following account from the field.

Pursuing a list of favorite collecting sites, the Limnology Class of the University of Kansas came to the Leavenworth County State Lake one sunny afternoon in April, last year. Along the shore the erratic tracery of the small molish burrowings of **Gryllotalpa** attracted a number of students who were soon digging excitedly in the loam. Most of the crickets, however, were evidently couched uneasily in their deeper burrows, for only a single bemused female was at length uncovered scarcely a yard from the water-edge. This specimen, **Gryllotalpa hexadactyla** Perty, remained hopefully 'possuming until lifted from its wrecked tunnel by the tweezers of the discoverer. It tumbled back to earth where desperate efforts to return underground were rudely discouraged. At bay, with threatening tweezers darting at its head and a bottle descending to receive its body, the odd little animal had provocation enough for its subsequent action.

Curving up the tip of the abdomen and spreading the two long caudal filaments, the mole-cricket forced out over its head a jet of fluid which vanished in the soil several inches away. The repugnant odor, so vividly described by Baumgartner, was hardly detectable among the usual earthy smells of damp lake shore. The body of the creature seemed innocent of offensive vapors which

*Contribution from the Department of Entomology, University of Kansas.

**Notably Dr. W. J. Baumgartner: Science, N. S., Vol. XXI, No. 544, p. 855, June 2, 1905, and Kans. Univ. Sci. Bull., Vol. V, No. 18, pp. 315-318, March, 1910.

is less surprising, for the material is certainly lethal to the species* which may be expected to rid itself completely of each discharge. The skunk, it will be remembered, is not an unpleasantly odoriferous animal, personally.

The amazing part of the mole-cricket's single defiant act was not in its performance, which is quite familiar to students of living specimens, but in its direction. That the fetid substance may be depended upon to protect the soft abdomen from rear attack, probably for the most part from cannibalistic associates, in the burrow, has been shown by the experiments of Baumgartner. A certain amount of aiming toward points of irritation in the rear has been noted also by that writer. But a shrewdly directed shot at an approach upon the head argues for the mole-cricket an intelligent use of its capabilities which entitles it to the respect of its adversaries and more careful attention from biologists.

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## HESSIAN FLY EGGS AND FREEZING TEMPERATURES.

**W. T. EMERY, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.**

An opportunity to observe the effect of freezing temperatures on the vitality of eggs of the hessian fly occurred unexpectedly in January, 1934. Several eggs on a blade of wheat were covered with water in a dish and placed in a cold room to prevent hatching before the larvae were desired. During the night a cold wave developed and the following day the wheat leaf and eggs were found embedded in ice. When thawed out the eggs hatched normally. These observations led to the planning and execution of an experiment to test the effects of freezing temperatures on hessian fly eggs.

McColloch (1) has noted that "temperatures as low as -21 degrees F. were recorded with no appreciable mortality to the flaxseed. Full grown larvae have also been known to survive a temperature of -16 degrees F." He further says "Temperatures of about 32 F. are fatal

* W. J. B., 1910.

(1) The Hessian Fly in Kansas. Tech. Bull. 11, Kans. State Agr. Coll., 1923.

to the adults and in many cases to the eggs and migrating larvae."

On January 5, 1934, blades of wheat bearing newly deposited eggs of the hessian fly were placed in a shell vial stoppered with wet cotton and exposed in a weather shelter at Wichita, Kans. At the end of 10 days, and each week thereafter until February 5, eggs were removed from the vial and brought into the laboratory. Some 276 larvae hatched from these eggs, a portion of which were transferred to wheat plants and developed normally to the puparium stage. A record of the exposure periods and of the minimum temperatures to which these eggs were subjected is shown in table 1.

**Table 1**

Effect of freezing temperatures on the egg stage of the hessian fly

| Date eggs were exposed to outdoor temp. | Date eggs were removed to laboratory | Eggs removed to laboratory | Days exposed | Minimum temp. to which eggs were exposed | Days with temp. below freezing. | Eggs hatched | |
|---|---|---|---|---|---|---|---|
| | | Number | Number | Degree F. | Number | Number | Percent |
| Jan. 5 | Jan. 15 | 200 | 10 | 17 | 7 | 66 | 33 |
| Do. | Jan. 22 | 150 | 17 | 17 | 11 | 42 | 28 |
| Do. | Jan. 29 | 145 | 24 | 14 | 17 | 125 | 86 |
| Do. | Feb. 5 | 97 | 31 | 11 | 22 | 43 | 44 |

The eggs removed to the laboratory on February 5 had been subjected to 200 hours of freezing temperatures, 18 of which were below 20 degrees F. with a minimum of 11 degrees F.

It is possible that the high relative humidity maintained in the vials by the use of the wet cotton stoppers was a factor in enabling the eggs to withstand the freezing temperatures.

# SOME NEW SPECIES MICROVELIA (VELIIDAE, HEMIPTERA)

A. P. McKINSTRY*

As a biproduct of a thoroughgoing morphological study of the genus Microvelia it is necessary to describe the new species below. In the University of Kansas Collection there are nearly ten thousand specimens from various places in the western hemisphere and these comprise forty-one species. The species containing apterous forms can be separated into Groups as follows:

**Group I:** Protergum not produced caudad of the suture between pro and mesotergum.

**Group II:** Protergum covering part or all of the mesotergum. The boundary between meso and metatergum being marked by the presence of two tiny pits in a suture about halfway between the median line and the pleural region.

**Group III.** Protergum covering all of mesotergum and most of metatergum, leaving only small triangular sclerites (metanotal angles) exposed.

### **Microvelia beameri** n. sp.

**Size:** Apterous male, length, 2.3-3 mm., width, 1 mm.; female, length, 2.5-3 mm., width, 1.25 mm. Winged male, 2.5-3 mm.

**Color:** Similar to **M. americana** (Uhl.), perhaps yellow-orange markings on protergum and connexivum a little darker. Venter dark brown.

**Structural Characteristics: Antennae;** segments 1 and 2 about equal, 3 slightly longer and 4 a little shorter than 1 or 2. **Tarsi;** about all the same length, segment 1 of middle tarsi not shorter than 2, also not shorter than segment 1 of hind tarsi. **Legs;** front femur of male with spine one-third distance from apex, hind femur of male without spines usually, hind tibia of male with brush-like comb as in **M. americana** (Uhl.). **Abdomen;** venter of male covered with long silky hair, somewhat concave. First genital segment with characteristic tufts of hairs near ventral posterior margin. Ventral posterior margin of first genital segment curving anteriorly at median line.

**Location of Types: Holotype,** winged male. Baboquiviri Mts., Ariz., 7-18-32, R. H. Beamer; **Allotype,**

*Contribution from Department of Entomology, University of Kansas

winged female, Orange Co., California, 7-14-29, R. H. Beamer; **Holomorphotype, Allomorphotype,** apterous male and female, Lemon Cove, California, 7-24-29, R. H. Beamer, in Francis Huntington Snow Entomological Collection, University of Kansas. **Paratypes** and **paramorphotypes,** numerous from the Southwest and California.

**Comparative Notes:** Similar to **M. americana** (Uhler) except larger and longer. Antennal segment 3 longer than 4 whereas **M. americana** is opposite. First genital segment characteristic.

**Data on Distribution:**

**Arizona:** Coconino Co., 7-1-29, R. H. Beamer; Cochise Co., 7-29-27,, R. H. Beamer; Baboquiveri Mts., 7-18-32, R. H. Beamer; Huachuca Mts., 7-8-32, R. H. Beamer; Santa Rita Mts., 7-17-32, R. H. Beamer; Santa Cruz Co., 8-4-27, R. H. Beamer; Tubac 6-25-33, Miami, 7-22-32, Maricopa, 7-2-29, R. H. Beamer.

**California:** Winters, 8-6-29, L. D. Anderson; Santa Ana Co., 7-30-32, R. H. Beamer; San Diego Co., 7-4-29, L. D. Anderson; Atascadero, 7-19-33, R. H. Beamer; Indio, 7-24-29, L. D. Anderson; Holtville, 7-2-29, R. H. Beamer; Lemon Cove, 7-24-29, R. H. Beamer; Calaveras Co., 5-29-31, Usinger; Gaviota, 7-29-33, R. H. Beamer; Salinas, 7-18-33, R. H. Beamer; Orange Co., 7-14-29, R. H. Beamer.

**Texas:** Valentine, 7-13-27, R. H. Beamer.

**Mexico:** Satillo Coahuila, 11-21-32, L. D. Tuthill.

**Microvelia fasciculifera** n. sp.

**Size: Apterous male,** length, 3-3.5 mm., width, 1 mm. **Apterous female,** length, 3.2-3.5 mm., width, 1.2-1.5 mm. Winged male, length, 3-3.5 mm., width, 1.4 mm.

**Color:** Ground color dark brown spotted with silvery white pubescence, transverse orange spot on protergum completely separated in middle, orange marks on connexivum absent. Legs of uniform light brown, slightly darker at joints. Winged protergum may have broken transverse spot or it may be entire, posterior margins yellow-orange not meeting in middle. Not much contrast between color of veins and cells of wings. Venter silvery grey.

**Structural Characteristics:** Two unique characters are observed in the males; retrorse spine on hind femur

one-third distance from base, and last abdominal sternite with cone shaped tuft of bristles. The females are large and the widest of abdomen of the southwestern species. **Antennae;** segments 1 and 4 equal, slightly longer than 2 and 3, which are equal. **Legs;** hind trochanter of male with tiny black tubercle on posterior surface. Hind tarsal segment 1 very slightly shorter than mid-tarsal segment 1. **Abdomen;** last tergite of male, square or wider than long. First genital segment with semicircular rim of short bristles just peeping out beyond last abdominal sternite in dried specimen. Anal lid and hypandrium, rounded, without lateral processes. **Thorax;** protergum of apterous form like **M. americana** (Uhl.) in not covering any of mesotergum.

**Location of Types:** Holotype, winged male, Huachuca Mts., Arizona, 7-8-32. R. H. Beamer; **Holomorphotype,** apterous male, Chiricahua Mts., Arizona, 7-8-32, R. H. Beamer; **Allomorphotype,** Alfred, Texas, 7-24-28, R. H. Beamer, in Francis Huntington Snow Entomological Collection, University of Kansas. Numerous paramorphotypes.

**Comparative Notes:** This is a typical member of Group I, which includes **M. americana** (Uhler) but unique characters mentioned above separate it from all others. The retrorse spur is sometimes degenerated to a mere speck, and again may be quite prominent.

**Data on Distribution:**

**Arizona:** Chiricahua Mts., 7-8-32, R. H. Beamer; Huachuca Mts., 7-8-32, R. H. Beamer, Santa Rita Mts., 7-17-32, R. H. Beamer.

**Texas:** Alfred, 7-24-28, R. H. Beamer.

**Microvelia myersi** n. sp.

**Size:** Winged male 1.6 mm. long, .6 mm. wide. Other forms not known.

**Color:** Ground color dark brown with markings of dull yellow. **Winged form;** protergum dark brown with transverse yellow band, posterior margins dark brown. Wings transparent white with light brown veins and darker markings in cells. All cells with white markings. Median cell with dark spur projecting basally from distal cross-vein. This mark does not touch a vein except at the distal side of the cell. It is not a vein. Venter, dull blue, connexivum yellow-orange. Legs white at bases,

brown distally.

**Structural Characteristics: Antennal formula**—1:2:3:4::14:9:18:30.

**Legs;** Hind femur of male with several short spines, hind tibia with many sharp spines pointing toward apex. Front femur without spines. Hind femur not twice as thick as hind tibia, ratio, femur:tibia::5:3. Other legs with femora as thin as tibiae.

**Tarsi;** Mid-tarsal segment 1, shorter than hind-tarsal segment 1, ratio, M1:H1::7:8.5. Fore-tarsi longest, front tibia not twice as long as front tarsi.

**Thorax;** Only the winged form is known to me but according to antennae, legs, and genitalia, I expect the apterous protergum to be similar to that of **M. albonotata** Champion and to be of the Group II type. **Abdomen;** small tubercle on median line of posterior margin of sixth (next to last) abdominal sternite of male.

**Location of Type; Holotype;** winged male, labeled Trinidad, 20.xi.1928, J. G. Myers, B. M. 1929-170; Exch. with British Museum; at Light; in Francis Huntington Snow Entomological Collection. Described from two winged male specimens.

**Comparative Notes;** The tiny tubercle on the sixth abdominal sternite is unique, also the genitalia are quite distinctive. All characters indicate a strong relationship to **M. albonotata** Champ. but this species is noticably smaller.

**Data on Distribution:**

**Trinidad;** 20.xi.1928, J. G. Myers

**Corumba;** Matt Grosso, (Purchased from Staudinger)

**Microvelia peruviensis** n. sp.

**Size:** Winged male, 1.8 mm. long, .6 mm. wide; winged female, 2.0 mm. long, .7 mm. wide; apterous male , 1.6 mm. long, .6 mm. wide; apterous female, 1.6-1.8 mm. long, .7 mm. wide.

**Color:** Ground color dark brown with markings of yellow. **Winged Form;** with usual transverse yellow-orange band on protergum, posterior margins of protergum not yellow. Wings with prominent veins of dark brown, with white cells between. Apical cell with ovoid white spot surrounded with dark brown. Medial cell with brown streak projecting inward from posterior

margin, not a vein. Legs brown, bases yellow. Venter, lead-blue. **Apterous Form;** Protergum with yellow transverse band, meso and metatergum yellow, metatergal triangles brown. Abdomen outlined in brown at sutures.

**Structural Characteristics:** Antennal formula—1:2:3:4:;14:9:19:21.

**Legs:** Hind femora twice as thick as tibia. Ventral surface of hind femora covered with short sharp spines. Apex of front tibia of male nearly as thick as front femur. **Tarsi;** front tarsi longer than middle and hind tarsal segments. First segments of middle and hind tarsi slightly shorter than second segments. **Thorax** apterous protergum barely covering a very small part of the mesotergum so that it resembles Group I. Other characters being considered we can easily see that this species is most closely related to **M. albonotata** Champion and therefore belongs in Group II. The winged form has no light stripe or spot running back from transverse orange-yellow spot on protergum as in **M. albonotata** Champion. **Abdomen;** seventh abdominal tergite of male slightly wider than long, ratio W:L::12:9. Seventh tergite about as long as fifth plus sixth. **Genitalia;** first genital segment of male prominent, hypandrium and anal lid lacking lateral projections or points as in **M. albonotata** Champ. Left clasper much larger than right, both straight, pointed at tip.

**Location of Types:** Holotype, winged male, Peru, S. America, Langunas Villa, Department of Lima, 1-8-34 to 6-1-34, F. Woytkowski; **Allotype;** Peru, S. America, Rio Rimac, 11-27-34, F. Woytkowski; **Holo** and **Allomorphotype;** apterous male and female, Peru, S. America, Lurin, Department of Lima, 11-3-34, F. Woytkowski; in Francis Huntington Snow Entomological Collection, University of Kansas. Short series of Paratypes and Paramorphotypes.

**Comparative Notes:** This species is closest in winged form to **M. albonotata** Champion, but it lacks the tubercle on the second abdominal sternite and the fourth antennal segment is shorter in comparison with the third than that of **M. albonotata.** The apterous form has a unique type of protergum and should be recognizable at once by it.

**Data on Distribution:**

**South America**

**Peru;** Dept. Lima, Lagunas Villa, June 1, 1934; Dept. Lima, Nov. 3, 1934; Rio Rimac, Nov. 27, 1934, F. Woytkowski.

**Microvelia hungerfordi** n. sp.

**Size: Winged male,** 4 mm. long, 1.3 mm. wide; **winged female,** 4 mm. long, 1.4 mm. wide; **apterous male,** 3.8 mm. long, 1.1 mm. wide; **apterous female,** 4 mm. long, 1.4 mm. wide.

**Color:** Ground color brown with rusty yellow markings. **Winged form;** transverse orange-yellow band on protergum present. It may or may not continue around on sides of prothorax. Posterior margins of protergum dirty-yellow, not broken at median line. Wings uniformly brown, veins indistinct. Veins in corium area sparsely covered with short shining hairs. Legs brown. yellow at bases. Venter shining lead-blue, sparse white pubescence covering all of ventral part of body. **Apterous form;** thorax and abdomen covered thinly with irregular shining white hairs. Markings indistinct except for transverse orange-yellow spot on protergum and rusty-yellow posterior margins of protergum.

**Structural Characteristics: Antennal formula**—1:2:3:4:;23:32:27:33.

**Legs:** femora and tibiae of males without spines. Femora not over twice as thick as tibiae. Front tibia more than twice as long as front tarsus. **Tarsi:** mid-tarsal segment 1: segments 2::19:18. Hind tarsal segment 1: segment 2 :: 25:17. **Thorax;** apterous protergum covering all of mesotergum except a tiny rim between phragmal pits. Protergum not fused with rest of thorax so that it will break away neatly. Distance between eyes: length of protergum :: 12:21. **Abdomen;** length of seventh tergite of male: width :: 12 : 10. Length of seventh tergite about equal to length of sixth plus fifth. Last abdominal sternite of male pinched together posteriorly to form keel-like ridge. **Genitalia;** first genital segment concave on ventral surface, two triangular projections on ventral surface near posterior margin. Anal lid and hypandrium without projections. Clasper triangular in outline, nearly as wide as long.

**Location of Type: Holotype, allotype,** winged male and female; **holomorphotype, allomorphotype,** apterous

male and female, labeled Argentina, S. A., La Granja Alta, gracia Cordoba, 1923, A. Bruch, in Francis Huntington Snow Entomological Collection, University of Kansas.

**Comparative Notes:** This species is similar to **M. longipes** Uhler as to thoracic tergum, but it is most closely related to **M. braziliensis** n. sp. which is slightly smaller. The most satisfactory character used in separating them is the antennae. The sternal keel on the last sternite of the males is unique in the two species, **M. hungerfordi** n. sp. and **M. braziliensis** n. sp.

**Data on Distribution:**

**South America**

**Argentina:** La Granja Alta, gracia Cordoba, 1923, A. Bruch.

**Paraguay:** Caraveni L. Miantis, 10-30-24, F. Schade.

**Microvelia braziliensis** n. sp.

**Size: Apterous female,** 3.1 mm. long, 1.1 mm. wide; **apterous male,** 3. mm. long, .9 mm. wide.

**Color:** Ground color brown with dull yellow markings. **Apterous form;** protergum with transverse orange-yellow band, posterior margins not yellow. Connexivum dull yellow. Sixth and seventh tergites of abdomen yellow-orange, nearly glabrous. Legs dull-yellow-orange, tips of segments darker. Venter yellow with dark lateral stripe. Entire body covered with short white irregular shining hairs.

**Structural Characteristics: Antennal formula—** 1:2:3:4:;20:18:31:33.

**Legs;** no spines on femora or tibiae of males. Femora about twice as thick as tibiae or less. Front tarsus less than half as long as front tibia. Mid-tarsal segment 1 : segment 2 :: 18: 14. Same is true of hind tarsi. Mid-tarsal segment 1 equal to hind tarsal segment 1. **Thorax;** protergum extending back over mesotergum exposing only a very small rim of posterior portion of mesotergum between phragmal pits. Distance between eyes : length of protergum:: 9: 12. **Abdomen;** Length of seventh tergite : width :: 10 : 8. Length of seventh tergite : fifth plus sixth :: 10: 9.5. Last sternite of male pinched together to form a keel-like ridge. **Genitalia;** first genital segment concave on ventral surface with two triangular projections near posterior margin. Anal lid and hypandrium without projections. Clasper triangular.

**(To be continued in Vol. 10, No. 2)**

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